

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

MINAMIDE et al.

Art Unit: Unknown

Application No.: Unknown

Examiner: Unknown

Filed: February 7, 2001

For: PROGRAMMABLE
CONTROLLER, AND
CONTROL-PROGRAM-
DEVELOPMENT
SUPPORTING
APPARATUS

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to the examination of the above-identified patent application, please enter the following amendments and consider the following remarks.

IN THE SPECIFICATION:

Replace the paragraph beginning at page 1, line 13 with:

Production equipment and production methods have rapidly changed in industrial fields, particularly in production fields, independent of the scale of a field, and the range of electrical-system controllers for equipment and systems for production has been increasing year after year. Therefore, it is important in communicating with a mechanical system, rationally to improve the cost performance, and realize a high-speed easy-to-handle user interface in this environment.

Replace the paragraph beginning at page 3, line 11 with:

Therefore, the programmable controller may use a configuration for receiving the instruction list and executing sequential processing in accordance with instructions shown by the instruction list. In this case, the programmable controller sequentially executes a control program by interpreting the received instruction list line by line, that is, by converting the list into code directly executable by a microprocessor mounted on the programmable controller. The programmable controller is hereafter referred to as interpreter-type programmable controller.

Replace the paragraph beginning at page 3, line 22 with:

Moreover, a compiling-type programmable controller is practically used as another type of programmable controller that receives directly-executable code from a control-program-development supporting apparatus through a microprocessor in the programmable controller and executes the codes. In the case of the configuration using the compiling-type programmable controller, a control-program-development supporting apparatus is provided with a compiler, which converts a ladder diagram directly or temporarily into an instruction list by the compiler and then compiles the list into code directly executable by the microprocessor and transfers the execution codes to the programmable controller.

Replace the paragraph beginning at page 4, line 20 with:

However, because the above control program depends on the vendor or type of programmable controller, it is impossible to execute the same sequential processing between different types of programmable controllers by using control programs having the same source code. Therefore, it is necessary to develop a new control program or transplant a new model or different model to a programmable controller and thus, it is difficult to effectively use past properties of a control program.

Replace the paragraph beginning at page 5, line 1 with:

For example, according to the advanced-language sequence instruction program generator and universal sequencer disclosed in Japanese Patent Laid-Open No. HEI 7-

295612, the advanced-language sequence instruction program generator translates a language sequence instruction program into an advanced-language sequence instruction program with a translation program and compiles the advanced-language sequence instruction program to generate an execution-type sequence instruction program. Or, the universal sequencer executes the advanced-language sequence instruction program while sequentially interpreting the program. Thereby, it is possible to execute sequential control with the same control program independently of the vendor or type of a sequencer.

Replace the paragraph beginning at page 6, line 24 with:

Firstly, there is a problem that, because a microprocessor in a universal computer (hereafter referred to as universal Microprocessor), such as a personal computer, operates with an advanced function at a high speed and has become inexpensively available in recent years, the advantage of developing a microprocessor in a conventional programmable controller with an ASIC (Application Specific IC) is slowly decreasing.

Replace the paragraph beginning at page 7, line 7 with:

Particularly, a universal microprocessor is provided with primary and secondary caches and constructed in accordance with acceleration of processing techniques such as pipeline processing, super-scaler processing and out-of-order processing and moreover, execution codes directly executable by the universal microprocessor are also generated by a compiler for converting the execution codes into execution codes forming an optimum code system by fully using the acceleration techniques.

Replace the paragraph beginning at page 8, line 14 with:

Fourthly, though the "advanced-language sequence instruction program generator" disclosed in the above Japanese Patent Laid-Open No. HEI 7-295612 generates an object file by converting a source file described with the control program of an instruction list or the like into the source file of an advanced programming language such as C language, if only the source file of the advanced programming language is corrected. There is a problem that two source files showing the same sequential processing do not match each

other because the source file of an original control program is not changed due to the above correction.

Replace the paragraph beginning at page 8, line 25 with:

Particularly, in the case of a control-program-development supporting apparatus capable of developing a control program with an advanced programming language, to perform step execution by using a debugging tool, for example, step execution is possible for one line of the advanced programming language but it is impossible to perform step execution every line for a language configuration such as an instruction list before conversion into an advanced programming language.

Replace the paragraph beginning at page 9, line 23 with:

Fifthly, to realize the above-described under-RUN writing method, there is a problem that a memory having the same size as a memory in which a control program currently executed is read must be separately prepared. Because a memory is generally expensive among hardware parts, a maker or user must make a large investment in order to realize the under-RUN writing method.

Replace the paragraph beginning at page 11, line 20 with:

An instruction interpreting unit is generally described with a structure of comparing input data with a pattern of the interpretation side and when the data and the pattern match each other, executing a previously-stored operation (action). Therefore, pattern matching of the instruction interpreting unit requires a lot of time when the operation is executed in the case of the interpreter type and when the operation is compiled in the case of the compiling type. Thus, both types have factors impeding productivity.

Replace the paragraph beginning at page 24, line 12 with:

Fig. 1 is a block diagram showing a schematic configuration of a programmable controller of a first embodiment;

Replace the paragraph beginning at page 24, line 18 with:

Fig. 3 is an illustration for explaining the generation of an execution code followed by division of a control program in a control-program-development supporting apparatus of a second embodiment;

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Fig. 5 is a table showing the relation between the number of steps and a divided file in the control-program-development supporting apparatus of the second embodiment;

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Fig. 11 is an illustration for explaining the generation of an execution code followed by division of a control program and conversion of the program into an advanced programming language in a control-program-development supporting apparatus of a third embodiment;

Replace the paragraph beginning at page 26, line 17 with:

Fig. 15 is an illustration for explaining the generation of an execution code of a control-program-development supporting apparatus of a fourth embodiment;

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Fig. 16 is a table showing sample programs and their sizes, and processing times in a control-program-development supporting apparatus of a fifth embodiment;

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Fig. 17 is an illustration for explaining the development environment and execution environment of a control program in a control-program-development supporting apparatus of a sixth embodiment;

Replace the paragraph beginning at page 27, line 16 with:

Fig. 22A and Fig. 22B are illustrations for explaining the replacement of an execution code using a binary patch in a programmable controller of a seventh embodiment;

Replace the paragraph beginning at page 27, line 19 with:

Fig. 23 is an illustration for explaining the generation of an execution code in a control-program-development supporting apparatus of an eighth embodiment;

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Fig. 24 is an illustration showing a source file that is the content of a control program in the control-program-development supporting apparatus of the eighth embodiment;

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Fig. 24 is an illustration showing a source file that is the content of a control program in the control-program-development supporting apparatus of the eighth embodiment;

Replace the paragraph beginning at page 28, line 2 with:

Fig. 25 is an illustration showing a C-language expression obtained by converting a compressed file in the control-program-development supporting apparatus of the eighth embodiment;

Replace the paragraph beginning at page 28, line 6 with:

Fig. 26 is an illustration for explaining compiling in a control-program-development supporting apparatus of a ninth embodiment; and

IN THE CLAIMS:

Replace the indicated claims with:

1. (Amended) A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes; and
a universal microprocessor including an acceleration unit, such as pipeline logic and a cache, and directly executing the execution codes.

2. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising a compiler which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.

3. (Amended) The control-program-development supporting apparatus according to claim 2 further comprising an optimization filtering unit which reconstructs the control program into an optimum code system by excluding not-cited variables and redundant codes and rearranging codes for locally arranging instructions for a common input or output device, wherein a control program optimized by said optimization filtering unit is newly used as the control program.

4. (Amended) The control-program-development supporting apparatus according to claim 2, further comprising a processing-time rough-estimating unit which has a relating table which relates a sample program having a known processing time with the control program corresponding to the execution codes to estimate sequential-processing execution time of a programmable controller in accordance with the relating table.

5. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a control-program dividing unit which divides the control program into a plurality of blocks; and

a compiler which compiles at least some of the blocks into execution codes directly executable by a programmable controller.

6. (Amended) The control-program-development supporting apparatus according to claim 5, wherein the programmable controller includes a universal microprocessor having an acceleration unit, such as pipeline logic and a cache.

7. (Amended) The control-program-development supporting apparatus according to claim 5, wherein the control program is a ladder diagram or an instruction list generated from the ladder diagram, and the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung in the ladder diagram to generate a program file for every block concerned.

8. (Amended) The control-program-development supporting apparatus according to claim 5, wherein the control program is a ladder diagram or an instruction list generated from the ladder diagram, and the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung serving as a jump destination for a jump instruction in the ladder diagram to generate a program file for every block.

9. (Amended) The control-program-development supporting apparatus according to claim 5, wherein

the control program is a ladder diagram or an instruction list generated from the ladder diagram, and

the control-program dividing unit extracts at least some rungs including instructions to a common input or output device from the ladder diagram, constitutes one block of at least some of the rungs extracted, and generates a program file for every block.

10. (Amended) The control-program-development supporting apparatus according to claim 5 further comprising an optimization filtering unit which reconstructs the control program into an optimum code system by excluding not-cited variables and redundant codes and rearranging codes for locally arranging instructions for a common input or output device, wherein a control program optimized by said optimization filtering unit is newly used as the control program.

11. (Amended) The control-program-development supporting apparatus according to claim 5, further comprising a processing-time rough-estimating unit which has a relating table which relates a sample program having a known processing time with the control program corresponding to the execution codes to estimate a sequential-processing execution time of a programmable controller in accordance with the relating table.

12. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a control-program dividing unit which divides the control program into a plurality of blocks;

a control-program converting unit which converts at least some of the blocks into advanced-language control programs described with a universal-computer-readable advanced language for every block; and

a compiler which compiles at least some of universal-computer-readable advanced programming languages corresponding to every block into codes directly executable by a programmable controller.

13. (Amended) The control-program-development supporting apparatus according to claim 12, wherein the programmable controller is provided with a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.

14. (Amended) The control-program-development supporting apparatus according to claim 12, wherein

the control program is a ladder diagram or an instruction list generated from the ladder diagram, and

the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung in the ladder diagram to generate a program file for every block.

15. (Amended) The control-program-development supporting apparatus according to claim 12, wherein the control program is a ladder diagram or an instruction list generated from the ladder diagram, and the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung, serving as a jump destination for a jump instruction in the ladder diagram, to generate a program file for every block.

16. (Amended) The control-program-development supporting apparatus according to claim 12, wherein

the control program is a ladder diagram or an instruction list generated from the ladder diagram, and

the control-program dividing unit extracts at least some of rungs including instructions to a common input or output device from the ladder diagram, constituting one block of at least some of the extracted rungs, and generates a program file for every block.

17. (Amended) The control-program-development supporting apparatus according to claim 12 further comprising an optimization filtering unit which reconstructs the control program into an optimum code system by excluding not-cited variables and redundant codes and rearranging codes for locally arranging instructions for a common input or output device, wherein a control program optimized by said optimization filtering unit is newly used as the control program.

19. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a control-program converting unit which converts the control program into an advanced-programming-language control program described with a universal-computer-readable advanced programming language;

a debugging-code generating unit which generates a debugging control program by inserting a line number into a part corresponding to each line, constituting the instruction list in source codes, constituting the advanced-programming-language control program; and

a debugging executing unit which displays each line of the instruction list and the execution part of the advanced-programming-language control program by relating the former with the latter.

20. (Amended) A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, comprising:

a first storing unit which stores the execution codes;

a second storing unit which stores the data for the difference between an execution code stored in the first storing unit and a new execution code;

a microprocessor for direct execution of the execution codes; and

a patch processing unit which changes an execution code currently executed to a new execution code at a predetermined timing in accordance with the difference data and continuously executing the changed execution code.

21. (Amended) A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes; and

a microprocessor for directly executing the execution codes, wherein the execution codes include binary data generated by compressing the control program.

22. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control program, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

- a compressing unit which compresses the control program to generate a compressed file;

- a code converting unit which generates compressed data obtained by converting the compressed file into the code system of the control program; and

- a compiling unit which combines the control program with the compressed data and compiles the combined result into codes directly-executable by a programmable controller.

23. (Amended) A programmable controller which performs sequential processing in accordance with a control program described with a sequential-control language, such as a ladder diagram or instruction list, said programmable controller comprising:

- a storing unit which stores the control program;

- an instruction counting unit which counts the appearance frequency of each instruction used for execution of the control program;

- a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency in accordance with results counted by the instruction-counting unit; and

- an interpreting unit which executes the control program while pattern-matching the instructions listed in the pattern-matching-table in order and interpreting the control program into codes directly-executable by the programmable controller.

24. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder

diagram or instruction list, said control-program-development supporting apparatus comprising:

- an instruction counting unit which counts the appearance frequency of each instruction used for the control program;
- a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency, in accordance with results counted by the instruction-counting unit; and
- a compiler which compiles the control program into codes directly executable by the programmable controller while pattern-matching the instructions listed in the pattern matching table in order.

25. (Amended) A programmable controller that performs sequential processing in accordance with execution code s generated by compiling a control program, said programmable controller comprising:

- a storing unit which stores the execution codes;
- a universal microprocessor including an acceleration unit, such as a pipeline logic and a cache, and directly executing the execution codes; and
- a control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, the control-program-development supporting apparatus having a compiler which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration mounting unit, such as a pipeline logic and a cache.

26. (Amended) A programmable controller -that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

- a storing unit which stores the execution codes;
- a universal microprocessor which includes an acceleration mounting unit, such as pipeline logic and a cache, and directly executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or instruction list, the control-program-development supporting apparatus having,

a control-program dividing unit which divides the control program into a plurality of blocks; and

a compiler which compiles at least some of the blocks into execution codes directly executable by a programmable controller.

27. (Amended) A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor which includes an acceleration mounting unit, such as pipeline logic and a cache, and directly executing the execution codes; and

a control-program-development supporting apparatus that develops a control program, described with a sequential-control language such as a ladder diagram or instruction list, the control-program-development supporting apparatus having,

a control-program dividing unit which divides the control-program into a plurality of blocks;

a control-program converting unit which converts at least some of the blocks into advanced-language control programs described with a universal-computer-readable advanced language for every block; and

a compiler which compiles at least some of universal-computer-readable advanced programming languages corresponding to every block into codes directly executable by a programmable controller.

28. (Amended) A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor including an acceleration mounting unit, such as pipeline logic and a cache, and directly executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, the control-program-development supporting apparatus having,

a control-program converting unit which converts the control program into an advanced-programming-language control program described with a universal-computer-readable advanced programming language;

a debugging-code generating unit which generates a debugging control program by inserting a line number into a part corresponding to each line constituting the instruction list, in source codes constituting the advanced-programming-language control program; and

a debugging executing unit which displays each line of the instruction list and the execution part of the advanced-programming-language control program by relating the former with the latter.

29. (Amended) A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor including an acceleration unit, such as pipeline logic and a cache, and directly executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or instruction list, the control-program-development supporting apparatus having,

an instruction counting unit which counts the appearance frequency of each instruction used for the control program;

a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency in accordance with results counted by the instruction-counting unit; and

a compiler which compiles the control program into codes directly executable by the programmable controller while pattern-matching the instructions listed in the pattern matching table in order.

30. (Amended) A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, comprising:

- a first storing unit which stores the execution codes;
- a second storing unit which stores the data for the difference between an execution code stored in the first storing unit and a new execution code;
- a microprocessor directly executing the execution codes;
- a patch processing unit which changes an execution code currently executed to a new execution code at a predetermined timing in accordance with the difference data and continuously executing the changed execution code; and
- a control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, the control-program-development supporting apparatus having a compiler which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.

31. (Amended) A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

- a storing unit which stores the execution codes; and
- a microprocessor directly executing the execution codes, wherein
 - the execution codes include binary data generated by compressing the control program; and
 - a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or instruction list, the control-program-development supporting apparatus having a compiler

which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.

32. (Amended) A programmable controller which performs sequential processing in accordance with a control program described with a sequential-control language, such as a ladder diagram or instruction list, said programmable controller comprising:

a storing unit which stores the control program;

an instruction counting unit which counts the appearance frequency of each instruction used for the control program;

a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency in accordance with results counted by the instruction-counting unit;

an interpreting unit which executes the control program while pattern-matching the instructions listed in the pattern-matching table in order and interpreting the control program into codes directly-executable by the programmable controller; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or instruction list, the control-program-development supporting apparatus having a compiler which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.

IN THE ABSTRACT:

Replace the Abstract with:

ABSTRACT OF THE DISCLOSURE

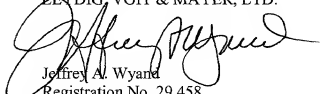
A programmable controller includes a universal microprocessor. This universal microprocessor incorporates an acceleration section. The control-program-development supporting apparatus generates an execution code directly executable by the universal microprocessor. Thereby, the acceleration section executes sequential processing.

REMARKS

The foregoing Amendment improves the form of the application without adding new matter.

Respectfully submitted,

LEYDIG, VOIT & MAYER, LTD.



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**SPECIFICATION, CLAIMS AND
ABSTRACT AS PRELIMINARILY AMENDED**

Amendments to the paragraph beginning at page 1, line 13:

Production ~~equipments~~ equipment and production methods ~~have been~~ rapidly changed in industrial fields, particularly in production fields ~~independently, independent~~ of the scale of a field, and the range of electrical-system controllers for ~~equipments~~ equipment and systems for production has been ~~increased~~ increasing year-by-year. Therefore, it is important ~~how to communicate in communicating~~ with a mechanical system, rationally to improve the cost performance, and realize a high-speed easy-to-handle user interface ~~under the above in this~~ environment.

Amendments to the paragraph beginning at page 3, line 11:

Therefore, the programmable controller may use a configuration for receiving the instruction list and executing sequential processing in accordance with instructions shown by the instruction list. In this case, the programmable controller sequentially executes a control program by interpreting the received instruction list ~~one line by one line~~, that is, by converting the list into code directly- executable ~~codes~~ by a microprocessor mounted

on the programmable controller. The programmable controller is hereafter referred to as interpreter-type programmable controller.

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Moreover, a compiling-type programmable controller is practically used as another type of programmable controller that receives directly-executable ~~codes~~ code from a control-program-development supporting apparatus ~~by through~~ a microprocessor ~~mounted on in~~ the programmable controller and executes the codes. In the case of the configuration using the compiling-type programmable controller, a control-program-development supporting apparatus is provided with a compiler, which converts a ladder diagram directly or temporarily into an instruction list by the compiler and then, compiles the list into code directly- executable ~~codes~~ by the microprocessor and transfers the execution codes to the programmable controller.

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However, because the above control program depends on the ~~header~~ vendor or type of ~~a~~ programmable controller, it is impossible to execute the same sequential processing between different types of programmable controllers by using control programs having the same source code. Therefore, it is necessary to develop a new control program or transplant a new model or different model to a programmable controller and thus, it is difficult to effectively use past properties of a control program.

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For example, according to the advanced-language sequence instruction program generator and universal sequencer disclosed in Japanese Patent Laid-Open No. HEI 7-295612, the advanced-language sequence instruction program generator translates a ~~sequence-instruction~~ language sequence instruction program into an advanced-language sequence instruction program with a translation program and compiles the advanced-language sequence instruction program to generate an execution-type sequence instruction program. Or, the universal sequencer executes the advanced-language sequence instruction program while sequentially interpreting the program. Thereby, it is

possible to execute sequential control ~~by~~ with the same control program independently of the ~~sender~~ vendor or type of a sequencer.

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Firstly, there is a problem that, because a microprocessor ~~mounted on~~ in a universal computer (hereafter referred to as universal Microprocessor), such as a personal computer, operates with an advanced function at a high speed and ~~can be~~ has become inexpensively available in recent years, the advantage of developing a microprocessor ~~mounted on~~ in a conventional programmable controller with an ASIC (Application Specific IC) is slowly ~~decreased~~ decreasing.

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Particularly, a universal microprocessor is provided with primary and secondary caches and constructed in accordance with ~~the acceleration-mounting arts of processing~~ techniques such as pipeline processing, super-scalar processing and out-of-order processing and moreover, execution codes directly executable by the universal microprocessor are also generated by a compiler for converting the execution codes into execution codes forming an optimum code system by fully using the acceleration ~~mounting arts~~ techniques.

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Amendments to the paragraph beginning at page 27, line 19:

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Amendments to the paragraph beginning at page 28, line 2:

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Amendments to existing claims:

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a storing unit which stores the execution codes; and

a universal microprocessor ~~which mounts~~ including an acceleration ~~mounting~~ unit, such as a pipeline logic and a cache, and ~~which is directly executed by~~ executing the execution codes.

2. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising a compiler which compiles the control program into codes directly executable by a universal microprocessor that ~~mounts~~ includes an acceleration ~~mounting~~ unit, such as a pipeline logic and a cache.

3. (Amended) The control-program-development supporting apparatus according to claim 2 further comprising an optimization filtering unit which reconstructs the control program into an optimum code system by excluding not-cited variables and redundant codes and rearranging codes for locally arranging instructions for a common input or output device ~~is included~~, wherein a control program optimized by said optimization filtering unit is newly used as the ~~former~~ control program.

4. (Amended) The control-program-development supporting apparatus according to claim 2, further comprising a processing-time rough-estimating unit which has a relating table which relates a sample program having ~~the a known~~ processing time ~~already known~~ with the control program corresponding to the execution codes to estimate a sequential-processing execution time of a programmable controller in accordance with the relating table.

5. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a control-program dividing unit which divides the control program into a plurality of blocks; and

a compiler which compiles ~~all or~~ at least some of the blocks into execution codes directly executable by a programmable controller.

6. (Amended) The control-program-development supporting apparatus according to claim 5, wherein the programmable controller ~~is provided with~~ includes a universal microprocessor ~~that mounts~~ having an acceleration-mounting unit, such as a pipeline logic and a cache.

7. (Amended) The control-program-development supporting apparatus according to claim 5, wherein the control program is a ladder diagram or an instruction list generated from the ladder diagram, and the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung in the ladder diagram to generate a program file for every block concerned.

8. (Amended) The control-program-development supporting apparatus according to claim 5, wherein the control program is a ladder diagram or an instruction list generated from the ladder diagram, and the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung serving as a jump destination for a jump instruction in the ladder diagram to generate a program file for every ~~blocks concerned~~ block.

9. (Amended) The control-program-development supporting apparatus according to claim 5, wherein

the control program is a ladder diagram or an instruction list generated from the ladder diagram, and

the control-program dividing unit extracts ~~all or at least~~ some of rungs including instructions to a common input or output device from the ladder diagram, constitutes one block of ~~all or at least~~ some of the ~~extracted~~ rungs extracted, and generates a program file for every ~~blocks concerned~~ block.

10. (Amended) The control-program-development supporting apparatus according to claim 5 further comprising: an optimization filtering unit which reconstructs the control program into an optimum code system by excluding not-cited variables and redundant codes and rearranging codes for locally arranging instructions for a common input or output device ~~is included~~, wherein a control program optimized by said optimization filtering unit is newly used as the ~~former~~ control program.

11. (Amended) The control-program-development supporting apparatus according to claim 5, further comprising: a processing-time rough-estimating unit which has a relating table which relates a sample program having ~~the a known~~ processing time ~~already known~~ with the control program corresponding to the execution codes to estimate a sequential-processing execution time of a programmable controller in accordance with the relating table.

12. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a control-program dividing unit which divides the control program into a plurality of blocks;

a control-program converting unit which converts ~~all or at least~~ some of the blocks into advanced-language control programs described with a universal-computer-readable advanced language for every ~~blocks concerned~~ block; and

a compiler which compiles ~~all or at least~~ some of universal-computer-readable advanced programming languages corresponding to every ~~above~~ block into codes directly executable ~~codes~~ by a programmable controller.

13. (Amended) The control-program-development supporting apparatus according to claim 12, wherein the programmable controller is provided with a universal microprocessor ~~that mounts~~ includes an acceleration-~~mounting~~ unit, such as a pipeline logic and a cache.

14. (Amended) The control-program-development supporting apparatus according to claim 12, wherein

the control program is a ladder diagram or an instruction list generated from the ladder diagram, and

the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung in the ladder diagram to generate a program file for every block-~~concerned~~.

15. (Amended) The control-program-development supporting apparatus according to claim 12, wherein the control program is a ladder diagram or an instruction list generated from the ladder diagram, and the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung, serving as a jump destination for a jump instruction in the ladder diagram, to generate a program file for every ~~blocks concerned~~ block.

16. (Amended) The control-program-development supporting apparatus according to claim 12, wherein

the control program is a ladder diagram or an instruction list generated from the ladder diagram, and

the control-program dividing unit extracts ~~all or at least~~ some of rungs including instructions to a common input or output device from the ladder diagram, ~~constitutes~~ constituting one block of ~~all or at least~~ some of the extracted rungs, and generates a program file for every ~~blocks concerned~~ block.

17. (Amended) The control-program-development supporting apparatus according to claim 12 further comprising: an optimization filtering unit which reconstructs the control program into an optimum code system by excluding not-cited variables and redundant codes and rearranging codes for locally arranging instructions for a common input or output device ~~is included~~, wherein a control program optimized by said optimization filtering unit is newly used as the ~~former~~ control program.

19. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a control-program converting unit which converts the control program into an advanced-programming-language control program described with a universal-computer-readable advanced programming language;

a debugging-code generating unit which generates a debugging control program by inserting a line number ~~concerned~~ into a part corresponding to each line, constituting the instruction list in source codes, constituting the advanced-programming-language control program; and

a debugging executing unit which displays each line of the instruction list and the execution part of the advanced-programming-language control program by relating the former with the latter.

20. (Amended) A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, comprising:

a first storing unit which stores the execution codes;

a second storing unit which stores the data for the difference between an execution code stored in the first storing unit and a new execution code;

a microprocessor ~~to be directly executed by~~ for direct execution of the execution codes; and

a patch processing unit which changes an execution code currently executed to a new execution code at a predetermined timing in accordance with the difference data and continuously executing the changed execution code.

21. (Amended) A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes; and
a microprocessor ~~to be for directly-executed by~~ executing the execution codes, wherein the execution codes include binary data generated by compressing the control program.

22. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control program, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a compressing unit which compresses the control program to generate a compressed file;
a code converting unit which generates compressed data obtained by converting the compressed file into the code system of the control program; and
a compiling unit which combines the control program with the compressed data and compiles the combined result into codes directly-executable ~~codes~~ by a programmable controller.

23. (Amended) A programmable controller which performs sequential processing in accordance with a control program described with a sequential-control language, such as a ladder diagram or instruction list, said programmable controller comprising:

a storing unit which stores the control program;
an instruction counting unit which counts the appearance frequency of each instruction used for execution of the control program;

a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency in accordance with results counted by the instruction-counting unit; and

an interpreting unit which executes the control program while pattern-matching the instructions listed in the pattern-matching-table in order and interpreting the control program into codes directly-executable ~~execution codes~~ by the programmable controller.

24. (Amended) A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

an instruction counting unit which counts the appearance frequency of each instruction used for the control program;

a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency, in accordance with results counted by the instruction-counting unit; and

a compiler which compiles the control program into codes directly executable ~~codes~~ by the programmable controller while pattern-matching the instructions listed in the pattern matching table in order.

25. (Amended) A programmable controller that performs sequential processing in accordance with execution code s generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor ~~which mounts~~ including an acceleration ~~mounting~~ unit, such as a pipeline logic and a cache, and ~~which is directly executed by~~ executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, ~~which the~~ control-program-development supporting apparatus having a compiler which compiles the control program into codes directly executable by a

universal microprocessor ~~that mounts~~ includes an acceleration mounting unit, such as a pipeline logic and a cache.

26. (Amended) A programmable controller -that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor which ~~mounts~~ includes an acceleration mounting unit, such as ~~a~~ pipeline logic and a cache, and ~~which is directly executed by~~ executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or instruction list, ~~which the~~ control-program-development supporting apparatus having,

a control-program dividing unit which divides the control program into a plurality of blocks; and

a compiler which compiles ~~all or at least~~ some of the blocks into execution codes directly executable by a programmable controller.

27. (Amended) A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor which ~~mounts~~ includes an acceleration mounting unit, such as ~~a~~ pipeline logic and a cache, and ~~which is directly executed by~~ executing the execution codes; and

a control-program-development supporting apparatus that develops a control program, described with a sequential-control language such as a ladder diagram or instruction list, ~~which the~~ control-program-development supporting apparatus having,

a control-program dividing unit which divides the control-program into a plurality of blocks;

a control-program converting unit which converts ~~all or at least~~ some of the blocks into advanced-language control programs described with a universal-computer-readable advanced language for every blocks concerned block; and

a compiler which compiles ~~all or at least~~ some of universal-computer-readable advanced programming languages corresponding to every above block into codes directly executable ~~codes~~ by a programmable controller.

28. (Amended) A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor ~~which mounts~~ including an acceleration mounting unit, such as a pipeline logic and a cache, and ~~which is directly executed by~~ executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, ~~which the~~ control-program-development supporting apparatus having,

a control-program converting unit which converts the control program into an advanced-programming-language control program described with a universal-computer-readable advanced programming language;

a debugging-code generating unit which generates a debugging control program by inserting a line number ~~concerned~~ into a part corresponding to each line constituting the instruction list, in source codes constituting the advanced-programming-language control program; and

a debugging executing unit which displays each line of the instruction list and the execution part of the advanced-programming-language control program by relating the former with the latter.

29. (Amended) A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;
a universal microprocessor ~~which mounts~~ including an acceleration ~~mounting~~ unit,
such as a pipeline logic and a cache, and ~~which is directly executed by~~ executing the
execution codes; and
a control-program-development supporting apparatus that develops a control
program described with a sequential-control language such as a ladder diagram or
instruction list, ~~which the~~ control-program-development supporting apparatus having,
an instruction counting unit which counts the appearance frequency of each
instruction used for the control program;
a pattern-matching-table generating unit which generates a pattern-matching table
in which instructions are listed starting with the highest appearance frequency in
accordance with results counted by the instruction-counting unit; and
a compiler which compiles the control program into codes directly executable
~~codes~~ by the programmable controller while pattern-matching the instructions listed in the
pattern matching table in order.

30. (Amended) A programmable controller which performs sequential processing
in accordance with execution codes generated by compiling a control program,
comprising:

a first storing unit which stores the execution codes;
a second storing unit which stores the data for the difference between an execution
code stored in the first storing unit and a new execution code;
a microprocessor ~~to be directly executed by~~ executing the execution codes;
a patch processing unit which changes an execution code currently executed to a
new execution code at a predetermined timing in accordance with the difference data and
continuously executing the changed execution code; and
a control-program-development supporting apparatus that develops a control
program described with a sequential-control language, such as a ladder diagram or
instruction list, ~~which the~~ control-program-development supporting apparatus having a
compiler which compiles the control program into codes directly executable by a

universal microprocessor that ~~mounts~~ includes an acceleration-~~mounting~~ unit, such as a pipeline logic and a cache.

31. (Amended) A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes; and

a microprocessor ~~to be directly executed by~~ executing the execution codes, wherein

the execution codes include binary data generated by compressing the control program; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or Instruction list, ~~which the control-program-development supporting apparatus having a compiler which compiles the control program into codes directly executable by a universal microprocessor that~~ mounts includes an acceleration-~~mounting~~ unit, such as a pipeline logic and a cache.

32. (Amended) A programmable controller which performs sequential processing in accordance with a control program described with a sequential-control language, such as a ladder diagram or instruction list, said programmable controller comprising:

a storing unit which stores the control program;

an instruction counting unit which counts the appearance frequency of each instruction used for the control program;

a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency in accordance with results counted by the instruction-counting unit;

an interpreting unit which executes the control program while pattern-matching the instructions listed in the pattern-matching table in order and interpreting the control program into codes ~~directly-executable-execution-codes~~ by the programmable controller; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or instruction list, ~~which the~~ control-program-development supporting apparatus having a compiler which compiles the control program into codes directly executable by a universal microprocessor that ~~mounts~~ includes an acceleration ~~mounting~~ unit, such as a pipeline logic and a cache.

Amendments to the abstract:

ABSTRACT OF THE DISCLOSURE

~~The~~ A programmable controller ~~mounts an~~ includes a universal microprocessor. This universal microprocessor ~~comprises~~ incorporates an acceleration ~~mounting-art~~ section. The control-program-development supporting apparatus generates an execution code directly executable by the universal microprocessor. Thereby, the acceleration ~~mounting-art~~ section executes sequential processing.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

MINAMIDE et al.

Art Unit: Unknown

Application No.: Unknown

Examiner: Unknown

Filed: February 7, 2001

For: PROGRAMMABLE
CONTROLLER, AND
CONTROL-
PROGRAM-
DEVELOPMENT
SUPPORTING
APPARATUS

CLAIMS PENDING AFTER PRELIMINARY AMENDMENT

1. A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

- a storing unit which stores the execution codes; and
- a universal microprocessor including an acceleration unit, such as pipeline logic and a cache, and directly executing the execution codes.

2. A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising a compiler which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.

3. The control-program-development supporting apparatus according to claim 2 further comprising an optimization filtering unit which reconstructs the control program

into an optimum code system by excluding not-cited variables and redundant codes and rearranging codes for locally arranging instructions for a common input or output device, wherein a control program optimized by said optimization filtering unit is newly used as the control program.

4. The control-program-development supporting apparatus according to claim 2, further comprising a processing-time rough-estimating unit which has a relating table which relates a sample program having a known processing time with the control program corresponding to the execution codes to estimate sequential-processing execution time of a programmable controller in accordance with the relating table.

5. A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a control-program dividing unit which divides the control program into a plurality of blocks; and

a compiler which compiles at least some of the blocks into execution codes directly executable by a programmable controller.

6. The control-program-development supporting apparatus according to claim 5, wherein the programmable controller includes a universal microprocessor having an acceleration unit, such as pipeline logic and a cache.

7. The control-program-development supporting apparatus according to claim 5, wherein the control program is a ladder diagram or an instruction list generated from the ladder diagram, and the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung in the ladder diagram to generate a program file for every block concerned.

8. The control-program-development supporting apparatus according to claim 5, wherein the control program is a ladder diagram or an instruction list generated from the

ladder diagram, and the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung serving as a jump destination for a jump instruction in the ladder diagram to generate a program file for every block.

9. The control-program-development supporting apparatus according to claim 5, wherein

the control program is a ladder diagram or an instruction list generated from the ladder diagram, and

the control-program dividing unit extracts at least some rungs including instructions to a common input or output device from the ladder diagram, constitutes one block of at least some of the rungs extracted, and generates a program file for every block.

10. The control-program-development supporting apparatus according to claim 5 further comprising an optimization filtering unit which reconstructs the control program into an optimum code system by excluding not-cited variables and redundant codes and rearranging codes for locally arranging instructions for a common input or output device, wherein a control program optimized by said optimization filtering unit is newly used as the control program.

11. The control-program-development supporting apparatus according to claim 5, further comprising a processing-time rough-estimating unit which has a relating table which relates a sample program having a known processing time with the control program corresponding to the execution codes to estimate a sequential-processing execution time of a programmable controller in accordance with the relating table.

12. A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a control-program dividing unit which divides the control program into a plurality of blocks;

a control-program converting unit which converts at least some of the blocks into advanced-language control programs described with a universal-computer-readable advanced language for every block; and

a compiler which compiles at least some of universal-computer-readable advanced programming languages corresponding to every block into codes directly executable by a programmable controller.

13. The control-program-development supporting apparatus according to claim 12, wherein the programmable controller is provided with a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.

14. The control-program-development supporting apparatus according to claim 12, wherein

the control program is a ladder diagram or an instruction list generated from the ladder diagram, and

the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung in the ladder diagram to generate a program file for every block.

15. The control-program-development supporting apparatus according to claim 12, wherein the control program is a ladder diagram or an instruction list generated from the ladder diagram, and the control-program dividing unit divides the control program into a plurality of blocks at a predetermined rung, serving as a jump destination for a jump instruction in the ladder diagram, to generate a program file for every block.

16. The control-program-development supporting apparatus according to claim 12, wherein

the control program is a ladder diagram or an instruction list generated from the ladder diagram, and

the control-program dividing unit extracts at least some of rungs including instructions to a common input or output device from the ladder diagram, constituting one

block of at least some of the extracted rungs, and generates a program file for every block.

17. The control-program-development supporting apparatus according to claim 12 further comprising an optimization filtering unit which reconstructs the control program into an optimum code system by excluding not-cited variables and redundant codes and rearranging codes for locally arranging instructions for a common input or output device, wherein a control program optimized by said optimization filtering unit is newly used as the control program.

18. The control-program-development supporting apparatus according to claim 12, further comprising:

a processing-time rough-estimating unit which has a relating table which relates a sample program having the processing time already known with the control program corresponding to the execution codes to estimate a sequential-processing execution time of a programmable controller in accordance with the relating table.

19. A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

a control-program converting unit which converts the control program into an advanced-programming-language control program described with a universal-computer-readable advanced programming language;

a debugging-code generating unit which generates a debugging control program by inserting a line number into a part corresponding to each line, constituting the instruction list in source codes, constituting the advanced-programming-language control program; and

a debugging executing unit which displays each line of the instruction list and the execution part of the advanced-programming-language control program by relating the former with the latter.

20. A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, comprising:

- a first storing unit which stores the execution codes;
- a second storing unit which stores the data for the difference between an execution code stored in the first storing unit and a new execution code;
- a microprocessor for direct execution of the execution codes; and
- a patch processing unit which changes an execution code currently executed to a new execution code at a predetermined timing in accordance with the difference data and continuously executing the changed execution code.

21. A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

- a storing unit which stores the execution codes; and
- a microprocessor for directly executing the execution codes, wherein the execution codes include binary data generated by compressing the control program.

22. A control-program-development supporting apparatus that develops a control program described with a sequential-control program, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

- a compressing unit which compresses the control program to generate a compressed file;
- a code converting unit which generates compressed data obtained by converting the compressed file into the code system of the control program; and
- a compiling unit which combines the control program with the compressed data and compiles the combined result into codes directly-executable by a programmable controller.

23. A programmable controller which performs sequential processing in accordance with a control program described with a sequential-control language, such as a ladder diagram or instruction list, said programmable controller comprising:

a storing unit which stores the control program;

an instruction counting unit which counts the appearance frequency of each instruction used for execution of the control program;

a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency in accordance with results counted by the instruction-counting unit; and

an interpreting unit which executes the control program while pattern-matching the instructions listed in the pattern-matching-table in order and interpreting the control program into codes directly-executable by the programmable controller.

24. A control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, said control-program-development supporting apparatus comprising:

an instruction counting unit which counts the appearance frequency of each instruction used for the control program;

a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency, in accordance with results counted by the instruction-counting unit; and

a compiler which compiles the control program into codes directly executable by the programmable controller while pattern-matching the instructions listed in the pattern matching table in order.

25. A programmable controller that performs sequential processing in accordance with execution code s generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor including an acceleration unit, such as a pipeline logic and a cache, and directly executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, the control-program-development supporting apparatus having a compiler

which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration mounting unit, such as a pipeline logic and a cache.

26. A programmable controller -that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor which includes an acceleration mounting unit, such as pipeline logic and a cache, and directly executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or instruction list, the control-program-development supporting apparatus having,

a control-program dividing unit which divides the control program into a plurality of blocks; and

a compiler which compiles at least some of the blocks into execution codes directly executable by a programmable controller.

27. A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor which includes an acceleration mounting unit, such as pipeline logic and a cache, and directly executing the execution codes; and

a control-program-development supporting apparatus that develops a control program, described with a sequential-control language such as a ladder diagram or instruction list, the control-program-development supporting apparatus having,

a control-program dividing unit which divides the control-program into a plurality of blocks;

a control-program converting unit which converts at least some of the blocks into advanced-language control programs described with a universal-computer-readable advanced language for every block; and

a compiler which compiles at least some of universal-computer-readable advanced programming languages corresponding to every block into codes directly executable by a programmable controller.

28. A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor including an acceleration mounting unit, such as pipeline logic and a cache, and directly executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, the control-program-development supporting apparatus having,

a control-program converting unit which converts the control program into an advanced-programming-language control program described with a universal-computer-readable advanced programming language;

a debugging-code generating unit which generates a debugging control program by inserting a line number into a part corresponding to each line constituting the instruction list, in source codes constituting the advanced-programming-language control program; and

a debugging executing unit which displays each line of the instruction list and the execution part of the advanced-programming-language control program by relating the former with the latter.

29. A programmable controller that performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

a storing unit which stores the execution codes;

a universal microprocessor including an acceleration unit, such as pipeline logic and a cache, and directly executing the execution codes; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or instruction list, the control-program-development supporting apparatus having,

an instruction counting unit which counts the appearance frequency of each instruction used for the control program;

a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency in accordance with results counted by the instruction-counting unit; and

a compiler which compiles the control program into codes directly executable by the programmable controller while pattern-matching the instructions listed in the pattern matching table in order.

30. A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, comprising:

a first storing unit which stores the execution codes;

a second storing unit which stores the data for the difference between an execution code stored in the first storing unit and a new execution code;

a microprocessor directly executing the execution codes;

a patch processing unit which changes an execution code currently executed to a new execution code at a predetermined timing in accordance with the difference data and continuously executing the changed execution code; and

a control-program-development supporting apparatus that develops a control program described with a sequential-control language, such as a ladder diagram or instruction list, the control-program-development supporting apparatus having a compiler which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.

31. A programmable controller which performs sequential processing in accordance with execution codes generated by compiling a control program, said programmable controller comprising:

- a storing unit which stores the execution codes; and

- a microprocessor directly executing the execution codes, wherein

- the execution codes include binary data generated by compressing the control program; and

- a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or Instruction list, the control-program-development supporting apparatus having a compiler which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.

32. A programmable controller which performs sequential processing in accordance with a control program described with a sequential-control language, such as a ladder diagram or instruction list, said programmable controller comprising:

- a storing unit which stores the control program;

- an instruction counting unit which counts the appearance frequency of each instruction used for the control program;

- a pattern-matching-table generating unit which generates a pattern-matching table in which instructions are listed starting with the highest appearance frequency in accordance with results counted by the instruction-counting unit;

- an interpreting unit which executes the control program while pattern-matching the instructions listed in the pattern-matching table in order and interpreting the control program into codes directly-executable by the programmable controller; and
- a control-program-development supporting apparatus that develops a control program described with a sequential-control language such as a ladder diagram or instruction list, the control-program-development supporting apparatus having a compiler which compiles the control program into codes directly executable by a universal microprocessor that includes an acceleration unit, such as pipeline logic and a cache.